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Household Dependence on Forest Income in Selected Rural Communities in Zambia

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This article estimates the contribution of forests and woodland resources to the incomes of households living around six local forest reserves earmarked for the Joint Forest Management programme in Zambia. It identifies the key factors that influence their decisions to engage in commercial exploitation of forest resources. The analysis shows that, in addition to the subsistence use of forest resources, rural households earn 30 % of their cash income from harvesting and selling forest products. The amount of forest income that households earn varies significantly across study sites and is influenced by market and household level factors as well as the occurrence and abundance of forest products. Factors that influence the household entry and exit into forest extraction for sale, the forest income they can earn, and the relationship between forest extraction and agricultural production are examined and policy implications discussed.

1. Introduction¹

Poverty reduction strategies as expressed in the poverty reduction strategy papers (PRSP) developed at the beginning of the 21st century are valuable frameworks for dealing with Africa's development problems (Oksanen et al, 2003). For example, in Zambia, the PRSP and the Fifth National Development Plan emphasize agricultural development as a major engine of economic growth, and as a sector with a great potential for expanding employment and income generating opportunities for the rural poor in the country (Government of the Republic of Zambia (GRZ), 2002). The fact that most of the country's labour force is employed in agriculture is a further reason for the importance the Zambian government attaches to this sector. This focus on agriculture has, to some extent, ignored the critical interdependences that exist between agriculture and forestry and the role forests and woodland resources play in rural livelihood systems. This emphasis on agriculture is also reflected in the government poverty reduction expenditures where over 80% of poverty reduction expenditures are allocated to the agriculture sector, mainly through the fertilizer support programme and the purchase of maize through the Food Reserve Agency.

The role forests and forestry can play in the country's poverty reduction efforts has not received much policy attention in Zambia, nor indeed in several other

African countries. A review of PRSPs of many developing countries indicates that the role of the forest sector in poverty reduction strategies has been underplayed and considered only in superficial ways (Oksanen et al, 2003; Dasgupta, 1993). Even countries like Mozambique, Malawi and Zambia that explicitly mention the forest sector in their PRSPs still lack details on policies and programmes for enhancing the role of forests and forestry development in poverty reduction programmes. This marginalization of the forest sector can in part be attributed to inadequate policy relevant information to assist the government to effectively incorporate poverty-forest linkages in overall poverty assessments and development processes (Angelsen and Wunder, 2003). It is therefore important that efforts to conduct empirical assessments of poverty-forest and agriculture-forestry inter-dependencies are increased, and that estimates of the contribution of forests and woodland resources to rural livelihoods systems and incomes of people living at the forest frontier are taken into account when designing and implementing poverty reduction programmes. Such analysis, if replicated in several contexts, would sharpen our understanding of the poverty-forest interfaces and facilitate the identification of poverty interventions that can optimize opportunities in the forest sector to reduce rural poverty.

The role of forests and woodlands in poverty reduction and rural development is one of the most debated issues in the environment and development discourse, both at the national and international level (Angelsen and Wunder, 2003). But the empirical evidence of how much forests and woodland resources contribute to rural livelihoods and incomes is sparse, especially in the context of Southern Africa. Some notable exceptions include Cavendish (1999) and Campbell et al (2002) on Zimbabwe, and Fisher (2004) on Malawi. This article contributes to our understanding of poverty-forest relationships by: estimating the contribution of forest income to total household incomes of rural households in selected communities; analyzing the determinants of household forest reliance using an appropriate micro-economic framework; and examining the synergies between rural agricultural development and household reliance on forest income and by implication forest management and conservation in Zambia.

The results of this study suggest that forests and woodlands, in addition to being important sources of subsistence foods and materials, make a significant contribution to rural household income and consequently to poverty reduction. However, the importance of forests as a source of income varies geographically, over time and across households. The findings suggest that the degree of households' dependence on forests and household activity choice depends on a number of household and market factors, the key ones being: access to markets, household income and wealth, the stock and opportunity cost of labour, and the availability of forest exit options to the household. Results further suggest that increasing agricultural production and productivity reduce household reliance on forest income, and therefore can help to promote long-term forest conservation.

The rest of this article is organized as follows: section two presents background information on forest resource endowment and management in Zambia. The

derivation of theoretical and empirical models of forest income, sampling and data issues are presented in section three and empirical results in section four. Discussion of key findings and policy implications are presented in the final section.

2. Forest resources and management in Zambia

Zambia has vast forest resources with 67% of its total land area under forest cover. A recent forest inventory study estimates the country's standing stock at 2,954 million cubic metres and re-growth at 568 million cubic metres (Kalinda et al, 2008). The total below ground biomass is estimated at 346.9 million cubic metres and total above ground and below ground biomass estimated at 3,300.9 million cubic metres. The Maximum Allowable Cut (MAC) is estimated at 17.5 million cubic metres per year, of which 1.6 million cubic metres are from commercially valuable timber species. These estimates suggest that the country has sufficient stocks of wood resources to meet its current and future needs for wood fuel, construction timber and other forest products and services if properly managed. It is also estimated that households consume 6.359 million cubic metres of wood per year, with firewood and charcoal accounting for 85 % and extraction of construction poles and round timber for household and industrial use accounting for the remaining 15 % (Puustjarvi et al, 2005). This level of extraction represents 36% of the MAC estimated at 17.5 million cubic metres per annum (Kalinda et al, 2008) and is therefore sustainable. This potential should be exploited to develop forestry development and investment in wood processing to maximize local value addition to locally produced hardwood timber and expand income and employment opportunities for rural households.

Rural households are highly dependent on forest resources for subsistence foods and materials as well as for cash income. Over 90% of rural households depend on forests to meet their household energy requirements. The total extraction of wood and non-wood forest products average 30.6 % of the total household production (K720, 000 or approximately US\$200) per annum (Jumbe et al, 2008). It is further estimated that about 68% of forest products harvested by rural households are used to meet households' subsistence needs and only 32% is sold in local markets for cash or in exchange for household goods. Wood products account for 66 % of the total value of forest products harvested by households and non-wood forest products, mainly wild-foods, account for the remaining 34%. The amount of income derived from forest products by households in the richest quintile were three times more than households in the poorest quintile. This suggests that, while on aggregate poorer rural households harvest more from forests and woodlands, richer households extract and derive more benefits from forest resources in per-capita terms (Jumbe et al, 2008). High dependence on forest resources should encourage rural households to utilize and manage local forest resources more sustainably, and they can be expected to actively support forest management regimes that guarantee and secure their forest-based livelihood systems.

Kant and Berry (2001) have shown that while a wide range of optimal forest regimes exist for developing countries, the choice of the most suitable regime

depends on two broad factors: the level of socio-economic heterogeneity of forest users or communities and the extent of the household's dependence on the forest resource to be managed. Forest dependence captures direct and indirect current and future subsistence and commercial household dependence on the forest resources. The purpose of this article is to estimate the contribution of forest cash income to total household income and to identify factors that influence household decisions to engage in forest gathering or extraction for sale. This information is important in designing durable and successful collaborative forest management regimes and rural poverty reduction strategies.

In Zambia, over 67% of forests and woodland resources are located on customary land, 24% on State land (these are largely managed as protected areas for wildlife management) and about 10% fall on land under private leasehold tenure. Only 22% of the total forests and woodland resources are currently formally managed, where management in practice largely involves fire prevention and lax enforcement of access controls. Forty five per cent (45%) of the country's forests are under customary management and 33% of it is totally unmanaged (Kalinda et al, 2008). On aggregate, 78% of the total forestland in the country is currently not managed and about a third is either disturbed or degraded. Thus, efforts to bring unmanaged and degraded forests into some form of formal and sustainable management would significantly enhance the flow of forest products and services and contribute to environmental sustainability and mitigation of global warming through carbon sequestration and storage.

Most of the country's forests are on customary land. Joint Forest Management (JFM) should appeal to peasant households who are heavily reliant on these forests for their livelihood, but lack the technical knowledge and financial/material resources to sustainably manage these forests by themselves. Successful implementation of JFM will depend on the land tenure systems and the subsistence and commercial rewards households derive from these forests and other conditioning factors that determine household participation and collective action. In this context, knowledge of the amount of cash income rural households derive from local forests, and the extent of forest extraction for subsistence uses, is important in designing successful JFM regimes and in identifying strategies that would maximize the potential role forests and woodland resources can play in creating sustainable income opportunities for poverty reduction.

3. Theoretical and empirical framework

Theoretical framework and derivation of the forest income equation

In this section, the forest income (output) function is derived from a short-run profit function. The profit function is estimated as a measure of welfare or benefit from harvesting products from local forests, and is used as a proxy measure of household welfare derived from commercial exploitation of local forest resources (Butry and Pattanayak, 2001). The profit function is in this context used to measure household dependency on local forests for cash income. Forest cash income is assumed to be increasing in forest income but decreasing in cost of forest

extraction. The cost of harvest depends on a number of factors, but more directly on input prices, resource scarcity and a host of other market and institutional factors. The short-run profit function is modelled as a function of exogenous factors, which broadly embraces input and output prices and fixed socio-economic variables such as age, gender, marital status and education (Sadoulent and de Janvry, 1995). Inclusion of these socio-economic and institutional factors is justified by the prevalence of market imperfection and high transaction costs in peasant economies (Pattanayak and Kramer, 1997).

From the profit function, the forest income equation is derived as a function of not only input and output prices but also socio-economic and environmental factors such as forest condition and scarcity of forest products and services. These factors help us to identify the key determinants of household dependence on forest resources as a source of income. This theoretical framework also enables us to analyse the effects of input and output prices, though rather indirectly due to lack of quality price data, after accounting for such conditioning factors as household characteristics, social capital, market access, non-forest income options, and environmental and institutional variables that define access and utilization of forest resources in each of the six forest areas covered in this article.

Since this article focuses narrowly on analyzing the key determinants of household dependency on forest income, the typical problems of non-separability of household production and consumption decisions is of less importance to the choice of the model and estimation procedures. This framework does not impose strict profit maximizing behavior on rural households because their decision to commercially exploit local forest resources for cash income is generally consistent with the standard behavioural assumptions that underlie utility and profit maximization. These assumptions include the need to have stable demand and supply functions.

Factors that can influence household supply of forest products and forest income were broadly categorized into three. First, there are factors that are fixed to the household (land, cattle, labour etc). Second, those factors which cannot easily be varied in the short run mainly because they exhibit features of public goods such as forest services. Third, there are institutional factors that impose constraints on the household production function such as the nature of the forest management regime and access to input and output markets.

Labour is probably the single most important input in the harvesting of forest products, although capital inputs may also be important, especially in the harvesting of timber and construction poles and in charcoal production and marketing. Since inputs used in harvesting and collecting forest products are fixed in the short-run, the short-run profit function can simply be specified as follows:

$$\pi = py - wl \quad (1)$$

where π is a vector of profit derived from harvesting forest products by a household, p is a vector of prices of forest products harvested for sale, y is a vector of outputs of forest products, w is a vector of input prices and l is a vector of input

quantities. Production and profit maximization is a function of available technology, which is assumed to be concave, continuous and at least twice differentiable, socio-economic variables (labour, age, gender, norms, beliefs, ethnicity, educational attainment etc) and institutional factors (harvest rules, distance to markets, quality and abundance of forest resources etc). Socio-economic and institutional variables are denoted by z . The household production function can now be specified as $y = f(l, z)$ and the input-demand and output supply functions respectively specified as a function of input prices (w), output prices (p) and socio-economic and institutional factors (z) as $l = l(p, w, z)$ and $y = y(p, w, z)$.

Substituting the input-demand and output-supply function into the short-run profit function above yields a new profit function expressed as a function of input prices, output prices and socio-economic and institutional factors as follows:

$$\pi = py(p, w, z) - wl(p, w, z) \quad (2)$$

Taking first order conditions with respect to w and p yields the following optimal (profit-maximizing) input demand and supply functions 3(a) and 3(b).

$$l^* = - \frac{\delta \pi(p, w, z)}{\delta w(p, w, z)} \quad (3a)$$

$$y^* = \frac{\delta \pi(p, w, z)}{\delta p(p, w, z)} \quad (3b)$$

Furthermore, substituting 3(a) and 3(b) into (2), yields the maximum (optimal) profits ($\pi^*(p, w, z)$) that a typical household can earn by employing all its inputs efficiently for a given production technology.

Equation 3(b) shows that harvesting of forest products is a function of input prices (of labour and tools, etc), market prices of forest products, and fixed socio-economic and institutional variables. Equation 3(b) is the forest cash income equation, with inputs and output prices and socio-economic and institutional factors being its major determinants. The econometric model and estimation procedures are discussed below.

Empirical model and estimation

The empirical model of forest income is specified and estimated in two stages. Firstly we estimate the model to identify factors that influence the household's decision to engage in the harvesting of forest products for sale, secondly, to isolate the key determinants of household forest income and by implication rural households' commercial dependence on local forest resources.² Since the first estimation implies a binary choice or outcome for households, a *logit* regression model is used to analyse factors that influence entry and exit in forest resource extraction for sale. The second estimation seeks to identify factors that influence the level of forest

income that the household earns from harvesting and selling forest products. For this purpose, a standard *tobit* regression model is used to identify the key determinants of household dependence on forest-based income in the study area.

With the exception of protected forests (forest reserves), most forest resources in unprotected forests are harvested under open access conditions, and land for agriculture and settlement is generally abundant and is administered by customary authorities/leaders. Thus the major constraints facing a typical rural household in the study area are scarcity of labour and labour augmenting inputs such as capital and raw materials. In this context, the amount of labour allocated to harvesting forest products for sale is expected to largely depend on factors that influence the net returns from forest gathering relative to competing uses of labour. Households combine their labour efforts with some capital (tools) or technology in order to increase production efficiency and lower transaction costs. Household endowments and socio-economic conditions are therefore expected to influence decisions on labour allocation and reliance on forest and woodland resources as sources of household income.

Access to markets and forest resources, spatial and temporal abundance of forest products, and relative prices of production inputs and outputs are expected to influence intra-household labour allocation decisions and consequently the quantity and value of forest products harvested for sale and for subsistence use. The general hypothesis here is that physical and economic scarcity of forest resources, the opportunity cost of labour, minimum household consumption requirements of forest products, market conditions and access to markets, and household socio-demographic factors (poverty levels, gender, household lifecycle etc) influence household decisions to engage in forest-based income generating activities. The estimable model of forest income can therefore be specified as:

$$FORINC_i = \alpha_{i1} + \sum_{j=2}^n \beta_{ij} \ln X_{ij} + \varepsilon_i \quad (4)$$

where *FORINC*, the dependent variable, denotes forest income earned by the household, X_{ij} , is a set of explanatory variables, α and β are parameters to be estimated, ε is the random term and *i* and *j* indexes individuals and study sites respectively. For the logit regression model, the dependent variable *FORINC* takes the value of one for households who reported earning income from selling forest products and zero otherwise. The econometric model is specified as

$$FORINC_i = \alpha_{i1} + \beta_{11}LWEALTH + \beta_{21}LINCOME + \beta_{31}ACCESS + \beta_{41}LNHA + \beta_{51}FUEL + \beta_{61}WOOD + \beta_{71}WDFOOD + \beta_{81}GENDER + \beta_{91}AGE + \beta_{101}MARITAL + \beta_{111}ROPENFR + \varepsilon_i \quad (5)$$

The logarithm of household assets (*LWEALTH*) and total household income (*INCOME*) capture the effect of household wealth/income on the likelihood that a household will derive income from forest products and the amount of forest income one can possibly earn. The household's decision to harvest forest products also

depends on geographical and temporal resource availability (Chidumayo and Mbata, 2002). Developing broad and accurate measures of scarcity/availability of multiple forest products harvested under open access conditions is often difficult, especially where data is largely unavailable or of poor quality. In this article, household qualitative ranking of forest resource abundance in open forests relative to better managed and resourced local forest reserves were compiled and used to compute a proxy measure of physical resource abundance (ROPENFR).

Physical measures of resource scarcity often perform poorly as indicators of economic scarcity which is largely influenced by access to forest resources and to markets. Market access (ACCESS) measured in terms of distance to urban markets for forest products and distance to the nearest tarred road were used to capture the impact of access to markets for forest products on household forest income. The amount of land cultivated and planted in hectares (LNHA) captures the household's opportunity cost of labour devoted to harvesting forest products, the availability of forest exit options, and household's food security situation.

Households collect forest products to meet their daily consumption needs and use and the surplus is sold in local and urban markets. Households who are more reliant on forests for subsistence use are expected to be more knowledgeable about the rural environment and about the occurrence of forest products in their area. In order to capture this minimum household consumption of forest products, their local knowledge of the rural environment and the importance of forest products, information on household subjective ranking of the importance of different forest products was used to construct dummy variables on four broad categories of forest products, namely fuel wood (FUEL), timber and construction poles (WOOD), wild foods (WDFOODS) and other non food forest products uses such as forest dyes and medicines (NFOOD). Socio-economic variables capture the effects of demographic factors, such as gender, age, marital status and household life-cycle factors on household activity choice and reliance on forest-based income. Variable definitions and expected signs are summarized in table 1 below.

Table 1: Descriptive statistics, variable definition and expected signs

Variables	Description	Mean	Std.Dev.
Exogenous variables			
LNHA	log of hectares cultivated [-]	0.98	1.15
FOOD	1 if wildfood ranked at least second, and 0 otherwise [+]	0.62	0.49
FUEL	1 if fuelwood ranked at least second, and 0 otherwise [+]	0.63	0.48
WOODD	1 if wood products ranked at least second and 0 otherwise [+]	0.15	0.35
NFOOD	1 if forest herbs ranked at least second, and 0 otherwise [+]	0.03	0.16
ACCESS	1 if community along line of rail and zero otherwise [+]	0.45	0.50
LWEALTH	log of total household assets [+/-]	14.20	1.57
LTARRED	log of distance between village and nearest tarred road [-]	2.60	1.10
LNAGE	log of age of respondent [+/-]	1.58	0.15
LNHSZE	log of household size [+]	0.76	0.23

Table 1: Descriptive statistics, variable definition and expected signs (continued)

EDUDUM	1 if respondent has at least high school, 0 otherwise [+/-]	0.22	0.41
GENDUM	1 if respondent is male, zero otherwise [+/-]	0.55	0.50
MARIDUM	1 if respondent is married, 0 otherwise [+]	0.77	0.42
INCOME	log of total household income [+/-]	12.65	2.67
Endogenous variables			
FORINC	log of total household forest income	5.53	6.08
LCHARC	log of income from charcoal production	2.61	5.07
FORINCD	1 if household sells forest products, 0 otherwise	0.47	0.50

Note: [] are expected signs.

Sampling and data collection

The study setting was dictated by the policy and institutional framework that defined and selected local forest reserves to be part of the pilot JFM project. The forest policy was revised in 1998, and in 1999 the Forest Bill that legalized the establishment of local forests that would be eligible for JFM was introduced (ZPFA, 2000). Under the Provincial Forest Action Plan (PFAP), five local forest reserves, namely Chibwe forest reserve in Kapiri Mposhi district, Myafi and Chaba local forest reserves in Mkushi District, and Lukangaba and Mwewa forest reserves in Mansa and Samfya and one open access forest namely Nyampande open forest in Petauke were selected for the pilot JFM project. These six forest areas (which hereafter are also referred to as forest communities) were surveyed between the months of May and September in 2003 and are located in five rural districts in three of the nine provinces of Zambia. Of these local forest reserves, only Chibwe local forest reserve was close to the country's capital city Lusaka and therefore its wood resources are commercially attractive for charcoal production.

A survey was developed, pre-tested and administered to residents of randomly selected sparsely populated villages around these six forests. Some of these villages were dotted around the local forest with each village settlement having less than 20 households. This feature of rural settlements made data collection time consuming and costly.³ The absence of a systematic register on settlements and household population meant that a priori random sampling of households was not feasible. Rather, households were randomly intercepted by research assistants as they traversed villages surrounding the six local forests selected for the pilot JFM project.

Research assistants were final year undergraduate students recruited from the University of Zambia and trained to conduct face-to-face interviews in local languages. District forest officers accompanied and introduced the research team to Village Resource Management Committees (VRMC)⁴ and subsequently to the local people with whom meetings were held to explain the purpose of the study and to seek clearance from the local leadership. This approach helped to elicit cooperation and truthful responses from households during the interviews. The survey collected information on the volume and price of forest products harvested

both for own consumption and for sale in the village, at the road-side and in local markets. The survey also captured information about livelihoods and income generating activities, forest conditions and ranking of different forest products according to their importance to rural livelihoods. It also captured households' demographic and socio-economic information, households' reliance on forests and woodland resources, age of head of household, marital status, ethnicity and religious affiliation, among other demographic variables. In addition, focus group discussions were conducted with VRMCs and with selected local communities to obtain additional information that could not effectively be captured in the survey.

Given that most forest utilization and income data collected from households by means of a questionnaire was based on monthly or quarterly recall, it was important to ensure that the data collected was as accurate and reliable as possible. To improve data reliability, households were asked to report forest extraction quarterly (seasonally) and annually. This data was cross-checked for consistency and when differences between quarterly and annual estimates were large the household was probed on its estimates to close up the gap. Great care was taken to explain the units of measurements and in most cases the commonest unit of measure used was a 50 kg bag or gallon locally called *meda*. Local market prices were used to convert bartered sales into monetary units. It is important to emphasize that the data used in this study does not include forest products harvested for own consumption and the figures reported are gross and not net of harvesting or production costs. Non-monetary transfers across households were not captured in household transfers and remittances because collecting such information was difficult and proved very unreliable. However, data on household receipts of cash remittances and food for work payments were captured in the survey.

4. Result and Discussion

Descriptive analysis and results

A total of 289 households were interviewed. Of these, ten surveys were incomplete and therefore discarded. Twenty four percent (24%) of valid responses were collected from communities living around Chaba and Myafi forest reserves, 26 % from Lukangaba and Mwewa forest reserves and 28 % and 22 % from Nyampande Open forests and Chibwe forest reserve respectively. Almost all communities surveyed had stable populations with low inward and outward migration. Over 70 % of the people interviewed had stayed in the same village for more than 10 years and only 5 % migrated from other regions/provinces to settle in the area in the last five years.

Of the 279 valid responses, 54.5% and 45.5% were female and male respondents respectively, and 77% were married and 23% were either single, separated or widowed. Although no significant differences in age distribution and household size were observed across study sites, the average land cultivated, agricultural systems and household assets were different across communities. However, no significant variations in household ranking of different forest products and forest utilization across settlements and by gender were observed.

Households engaged in charcoal production for sale ranked fuel wood highest on the list of forest products they considered to be important to their own livelihoods. As expected, poorer communities (i.e. Mwewa and Myafi forest communities) appeared relatively more dependent on forests as sources of safety-nets and subsistence foods than for commercial purposes, as they had to travel 40 kilometres to reach the nearest local market.

Subsistence agriculture is the major source of employment for over 90% of the households interviewed in Lukangaba and Mwewa forest reserves. These households practice slash and burn cultivation (referred to as the chitemene system) and grow some of their crops on village gardens or small farms. The chitemene system is highly dependent on availability of trees and contributes to forest degradation in communities or forest areas where population density is relatively high. Nonetheless, chitemene system of cultivation continues to be an important substitute to modern fertilizer-based agriculture among poor households who cannot afford to purchase chemical fertilizers.

Dependence on open forests and woodlands for wild food (i.e. honey, mushrooms, tubers, berries, etc) and for fuel wood and construction poles was quite visible in all the communities. Approximately 16% of the households interviewed are highly dependent on charcoal production for sale (mainly residents of Chibwe and Lukangaba forest reserves) and another 11% harvest other forest products (thatching grass, mushrooms, berries and wild honey) for sale in nearby rural markets. Semi-formal employment in the agriculture and forestry sectors, and non-farm employment account for 13% and 4.3% respectively. The highest average household income derived from forest products (mainly hardwood timber) was in Nyampande (approximately US\$900 per household per year) followed by Chibwe residents (US\$450) who derived forest income from fuel wood, timber, wild honey and thatching grass which they sold to nearby tourist operators/lodges. Mansa, Myafi, Chaba and Mwewa received the least income from forest products in that order. Among the forest areas surveyed, Open Nyampande forest had more valuable stocks of timber trees in open access forests. Because of proximity to urban and peri-urban markets, charcoal production for sale was an important source of forest income in Chibwe and Lukangaba. Over 80% of the charcoal produced for sale in the country is unlicensed⁵.

Household dependence on forest income

Table 2 shows household income generating activities. Column 4 of Table 2 presents average income contribution to total household income by income generating activity. Income from selling forest products accounts for 30 % of the total household income in the study area. This is fairly comparable to environmental income estimates obtained by Cavendish (2000) for rural Zimbabwe.

Table 2: Estimated annual household income by source

Income sources	% of sample Population	mean income	% of HH income
Sale of agric products	44.4	832,305	47.1
Sale of livestock	17.2	137,282	3.0
Sale of forest products	19.4	1,194,426	29.4
Income from trading	8.2	1,057,870	11.1
Informal wage income	13.3	195,432	3.3
Formal wage income	2.5	657,714	2.1
Income from other sources	5.4	572,133	3.9
Total	100	n/a	100

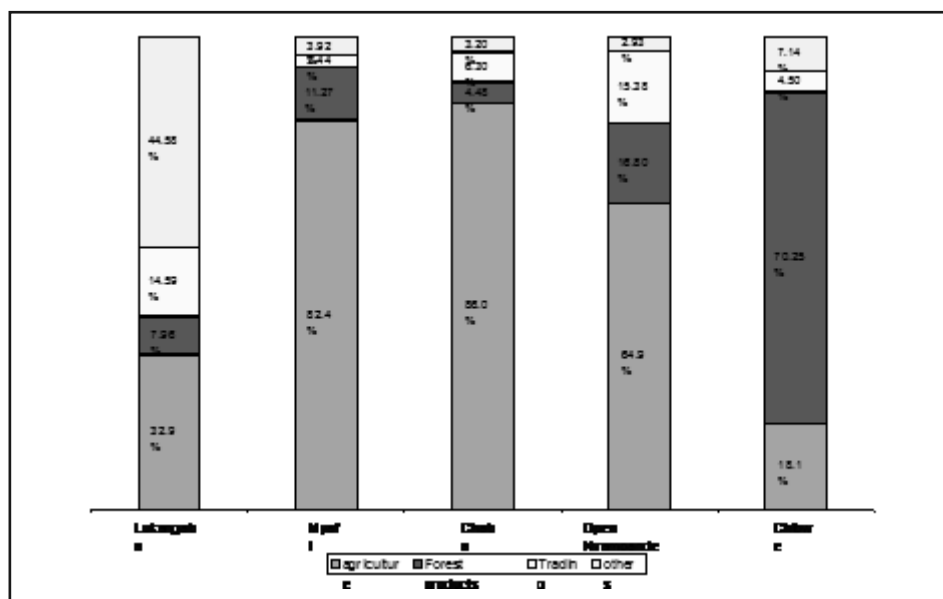
Notes:

- (i) Exchange rate was ZK4, 000 to US \$1 at the time of data collection.
- (ii) Income from trading excludes income from selling own-produced agriculture and forest products.

Figure 1 shows household income by study site and income generating activity. Households in the Myafi, Chaba, and Open Nyampande forest areas derive a greater part of household income from agriculture. Households living around Chibwe forest reserve obtained the greatest share of income from forest products, while those in Lukangaba in Mansa obtained most of their income from agriculture, wage employment, and trading in that order. Evidently, Chibwe forest communities are more reliant on forests and obtain more income from forests and woodland resources than from any other source. In this community, income from forest products and agriculture contribute 70% and 18% to household income and these activities involve more than 30% and 28% of the local populations, respectively. Effective demand and proximity to urban markets makes charcoal production and selling of thatching grass profitable for households living around Chibwe forest reserve. It is also important to note that despite the growth in urban demand for charcoal in the last three decades, positive returns from charcoal production have been sustained by low implicit wages in labour competing sectors such as agriculture (Chidumayo et, al., 2001). Because of this, charcoal production has continued to be an important source of employment and income for many labour surplus rural and peri-urban households.

In contrast, although residents of Nyampande open forest in Petauke district derive on average more income from forest products (mostly from hardwood timber) accounting for 16% of household income, this income accrues only to 10% of the local population. The contribution of forest income to total household income in other study sites range from 11% in Chaba local forest reserve to 4.5% in Myafi local forest reserve and involve less than 15% of the local population. Being the remotest of all the six forest communities surveyed, Mwewa (local forest reserve) residents derived the least income from forests and woodlands and only 2 percent of the local population is involved in harvesting forest products for sale. Most of their income came from such activities as basket-making, timber and canoe construction which were sold to fishermen and fish traders in local markets more than 40 kilometres

Figure 1: Percentage contribution to household income by different income generation activities weighted by number of households engaged in the activity



away from forest settlements. Because of the distance and poor roads both agriculture and forest activities generate very little cash income for these residents.

This analysis shows that harvesting of forest products and the amount of cash earned from the forest products depend on market factors (demand) and proximity to urban markets and on the type of forest products harvested and traded. Forest livelihoods are highly differentiated by gender, with women collecting non-wood products (wild foods, mushrooms, edible caterpillars etc) mainly for subsistence use and men harvesting timber, wood for charcoal, wild honey and other non-wood forest products for sale. Forest products and charcoal production in particular constitute the major sources of forest income for households living near urban and peri-urban centers. It is also shown that forest income contributes an average of 30 % to rural household income but this figure increases with proximity to urban markets.

Determinants of household forest income

About half of the households surveyed did not earn income from selling forest products (FORINC) and less than half earned income from charcoal production (CHARC). This implies that both the FORINC and CHARC dependant variables are censored at zero. The determinants of household reliance on forest income are analysed by estimating a Tobit model using the Maximum Likelihood (ML) procedure⁶. The logit model is estimated to analyse the determinants of the household's decision to harvest forest products for sale. The dependent variable in the logit model takes the value of 1 if a household earns some income from selling forest products and 0 otherwise. Results of the tobit and logit estimation are summarized in Table 3

Table 3: Determinants of Household dependence on forest income

	LOGIT ESTIMATES		TOBIT ESTIMATES	
	All forest products	Charcoal	All forest products	Charcoal Only
	Model 1	Marginal effects	Model 2	Model 3
ONE	-6.53 *** (4.90)	-1.61	-8.30*** (5.06)	-19.68* (1.73)
INCOME	0.35 *** (3.93)	.087	0.34*** (3.00)	1.40** (2.41)
ACCESS	0.66** (2.24)	.162	0.65** (1.93)	3.57** (1.90)
LNHA	-0.39*** (3.19)	-.096	0.55* (1.57)	-1.98*** (2.57)
MARIDUM	0.75** (2.33)	.176	-0.31** (2.10)	4.77** (2.32)
ROPENR	0.23 (1.10)	.056	0.70* (1.63)	1.06 (0.89)
NFOOD	-1.26 (1.28)	-.261	0.53 (0.51)	-8.99* (1.70)
FOOD	0.46* (1.52)	0.113	0.54* (1.57)	2.42 (1.43)
FUEL	0.76*** (2.13)	.183	1.60*** (3.00)	5.34** (2.29)
WOODD	1.60 *** (3.15)	.372	1.51** (2.26)	10.06*** (2.78)
LNAGE	—	—	—	-6.89 (1.42)
GENDUM	—	—	—	5.97** (2.09)
SIGMA	—	—	—	44.37*** (15.55***)
LOG-L	163.80	—	123.00	-688
Pseudo R2	15.10	—	15.00	adj. for Marginal effects .2023
% variation predicted	70.00	—	82.00	—
Sample	279	—	279	279

Note: ***, ** and * denotes statistical significance at 1%, 5% and 10% respectively.

Estimates in the Tobit model are not marginal effect, which can be obtained by multiplying the coefficients by a factor of 0.2023.

Results indicate that wood products, fuel-wood, access to markets (market integration) and wild-foods have the expected positive sign and influence the likelihood that a representative household will engage in commercial utilization of forest resources in the area. Household wealth has the expected sign and is statistically significant. Models 3 and 4 use logarithm of total household assets (wealth) in place of household income. Household wealth has a positive coefficient and is statistically significant in model 3 but negative and insignificant in the charcoal model. This result suggests that richer households earn relatively more money from forest products than poorer households. In addition, while richer households target high-value and somewhat capital intensive forest activities such as hardwood timber, poor households specialize in labour intensive and low-value forest products involving gathering of wild fruits, mushroom and honey and charcoal production for sale.

As expected, the physical stock variable, *ROPENFR*, has a positive but insignificant coefficient in all the estimations except in model 2 where it is only weakly significant. A positive sign on this variable suggests that as the forest resource becomes scarce, collection costs increase and net returns from gathering falls relative to returns from alternative employment. Economic scarcity of the resource, *ACCESS*, carries the expected sign and has a greater influence on household's forest entry and exit decisions and on the amount of forest income a household can possibly earn. This result implies that the shadow value of the resource increases as the resource becomes scarce. We also find a negative and statistically significant effect of acreage expansion on household forest participation rates (except in the charcoal sector) and reliance on forest income. Because increasing agricultural production and rural income increases the opportunity cost of labour devoted to forest activities, it reduces the amount of labour allocated to forest collection and consequently lowers household dependence on forest income. However, some households will continue harvesting commercially valuable forest products during the slack period when labour is relatively abundant. But the overall dependence on forest income will tend to decrease as returns from agriculture relative to forest utilization increase. A positive sign on *LnHA* in model 2 suggests that agricultural expansion and charcoal production appear to be complementary activities⁶. The results, however, show that doubling hectares planted would reduce household forest income and charcoal income by as much as 40% and 30% respectively — this is substantial given that most of the rural poor rely on forest income to purchase agriculture inputs such as seeds and chemical fertilizer (Chidumayo, 2001). While charcoal production may be associated with deforestation both in its own terms and as a causal agent, a significant amount of charcoal produced and supplied to urban markets could be coming from trees and forests cleared primarily for agricultural expansion.

In this case, estimates of charcoal-based deforestation must take this into account. The implication of this result is that policies aimed at raising agricultural productivity through agricultural intensification and which limit agricultural expansion at the extensive margin are expected to generate a greater positive impact on poverty reduction and forest conservation.

In terms of characteristics of forest users, results show that married households (MARIDUM) appear to be more reliant on forest incomes than those who are single. There are several reasons for this: married households tend to have relatively more labour to devote to forest gathering and marketing of forest products; and married households support a larger number of dependents, their own children and children from extended family circles, and as a result exhibit greater dependence on forests and woodlands to meet their dietary needs (Moore and Vaughan, 1994; Peckham, 1993), and to earn extra income to meet educational and health needs for their children and dependents.⁸ In addition, results suggest that younger people are more dependent on forest income than their older counterparts. These two findings indicate that household life-cycle and labour availability determine the degree of household dependence on forests and woodlands as sources of household income.

Wood products (timber and construction poles, thatching grass and reed mats) and fuel wood (mostly charcoal) are the most commercially exploited forest products in the study area. Very little income is derived from gathering wild foods such as mushrooms, edible caterpillars and wild fruits, mainly due to their variability in abundance and their low market value. Although medicinal forest products are rarely harvested for sale in the study area, a negative coefficient on NFOOD in models 1 and 3 is unanticipated. Traditional healers who collect herbs and medicinal forest products for sale come from urban and peri-urban towns where they practice as traditional healers. Even these collect medicinal herbs from forests nearest to urban markets (i.e. Chibwe forest reserve area). Any harvesting of herbs and medicine in the study was mostly for consumption.

5. Conclusion

This article estimates the contribution of forests and woodland resources to the incomes of rural households living around the six local forest reserves that have been earmarked for joint forest management in Zambia. Using an appropriate theoretical and empirical framework, the article investigates the major factors that influence entry and exit in forest extraction activities for commercial purposes and the amount of forest cash income households derive from forest products. With respect to forest cash income, the findings indicate that a typical household earns an average of K1,194,426 or US\$300 annually from harvesting and selling forest products. However, this amount may vary quite remarkably across study sites and households, with those in Nyampande and Chibwe local forests earning as much as US\$900 and \$450 per annum per household respectively. This accounts for 17% and 74% of their total household income. In the rest of the study sites, forest incomes were low and accounted for 4.5 to 11% of the total household income. On

average, forest income accounts for 30 % of gross household income in the study areas. This is quite significant, especially since it is more than the forest values extracted for substance uses and other forest services that support downstream and upstream income generating activities in the agriculture and wildlife and tourism sectors. The forest sector merits special policy attention beyond what we have seen reflected in the previous and current poverty reduction programmes and national development plans.

The second objective of the article was to investigate factors that influence households' entry and exit into the forest for commercial purposes and the determinants of household forest income. The empirical results indicate that both physical and economic scarcity of forest products, household income, and household minimum consumptive demand for forest products increase the likelihood that a typical rural household will engage in the extraction of forest products for sale. More interestingly, the results show that increasing land under crop cultivation (hectares planted) lowers the probability that the household will engage in gathering forest products for sale as well as the forest income they earn. This relationship however becomes positive and significant when only charcoal production and income is considered. These findings generate four important interpretations and policy implications.

Firstly, the negative relationship between land cultivated and entry into exploitation of forest resources and cash income derived from there implies that policies to improve agricultural production and hence household food security will lower household dependence on forest-based income, and by implication promote forest conservation, particularly when such policies promote agricultural intensification and minimize hectare expansion at the forest fringe. Secondly, the negative relationship between hectares planted and forest income suggests that when returns from agriculture increase, households allocate less labour to forest gathering relative to agriculture, thereby lowering income from and dependence on forest activities. Thirdly, the positive relationship between hectares cultivated and charcoal production for sale suggests that farm households utilize trees cleared during land preparation for crop cultivation to produce and sell charcoal to defray part of the cost of land clearance for agriculture or to purchase agriculture inputs, although the income earned from this one-time activity is relatively small and statistically insignificant. Finally, since a significant amount of charcoal supplied to urban markets is expected to come from forests cleared primarily for agricultural expansion, deforestation estimates from charcoal production that ignore charcoal produced from trees primarily felled in agricultural land clearance would over-state charcoal-based deforestation and possibly under-estimate forestland conversion to agriculture.

Lastly, the empirical results reveal that although on aggregate poorer households derive more income from forest exploitation; richer households actually derive more cash income from forest extraction in per-capita terms because they are able to argument their labour inputs with capital (tools and equipment) that enhances productivity, expands forest-based income generating

opportunities and enables them to access and sell their forest products in high-value markets. This means that, with the country's abundant forest and woodland resources, there is substantial scope for the government to exploit opportunities in the forest sector to generate more rural jobs and income by implementing policies and programmes to enhance access to production and process technologies, value addition, and marketing and commercialization of forest products in the country. Such interventions would enhance efforts to stimulate rural development and complement agricultural-based poverty reduction measures being implemented to reduce poverty in the rural sector.

Notes.

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2. In this analysis, forest dependence is defined in terms of household income derived from forest products and does not include imputed values of forest products harvested for own consumption or as inputs in household production activities. Unlike in such earlier studies as Cavendish (1998, 1999, 2000), Angelsen and Wunder (2003), Takasaki et al, (2004) and Coomes et al (2004) and Reardon and Vosti (1995)) which provide a framework for analyzing the poverty–environmental nexus, this paper narrowly focuses on the direct incomes households derive from harvesting and selling forest products and ignores forest products harvested for consumption within the household.
3. Because villages are small and scattered the Department of Forestry and its cooperating partners decided to purchase bicycles for VRMC in Lukangaba and Mwewa forest reserves to enable them to organize and attend meetings with district forest officers more regularly.
4. VRMC are the lowest structures on the JFM structure and organization and are responsible for the day to day implementation of the JFM program at the local level.
5. A lot of grey areas exist in charcoal licensing policy and these policy inadequacies encourage illegality and non-compliance in the charcoal industry. Reforming charcoal licensing policy is needed to promote development of the sector and its contribution to employment and income of those involved. Strategies to combat irresponsible harvesting and management of de-charcoaled forests are also needed to ameliorate its impact on forest conditions and regeneration.
6. To minimize heteroskedastic errors, non-zero values of forest income (FORINC) were transformed into logarithms (Fishe et al, 1981).
7. Earlier studies have shown that a good number of households use income from charcoal to purchase agricultural inputs and in this way forests subsidize agriculture and contribute to poverty reduction and food security at the household level (Chidumayo et al, 2001).
8. For instance, 13.6% of household in the Kopa area spent part of their income earned from caterpillar sales on school fees and related requisites (Chidumayo and Mbata, 2002). In rural Zimbabwe, results from Campbell, et al (2002) show that households falling in the first income quintile spend more time in the woodland and are more dependent on forests for subsistence than any other income group. And school children exert greater effort in collecting wild fruits than women in Zimbabwe (Campbell, 1989).

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